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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/866,665	05/30/2001	Takaharu Kondo	35.C15382	5130

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EXAMINER	
DIAMOND, ALAN D	

ART UNIT	PAPER NUMBER
1753	

DATE MAILED: 01/06/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/866,665	KONDO ET AL.	
	Examiner	Art Unit	
	Alan Diamond	1753	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12 October 2004*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1 and 3-15* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1 and 3-15* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 10-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Matsuda et al (U.S. Pat. No. 5,571,749) in view of Yamazaki (U.S. Pat. No. 6,028,264) and in view of Yamazaki (U.S. Pat. No. 5,556,794), herein referred to as US '749, US '264 and US '794, respectively.

US '749 discloses a method for producing silicon thin films, particularly for use in solar cells, using high-frequency plasma CVD (col. 15, line 9). US '749 discloses forming i-type silicon thin films using a material gas comprising silicon fluoride, hydrogen and oxygen (col. 15, lines 36-53; col. 33, line 60; col. 34, line 12). The flow rate of the hydrogen is usually much higher than the flow rate of the silicon containing gas (see Tables 1-5). The examples shown in US '749 are formed at pressures higher than 50 mTorr (Tables 1-5). US '749 further discloses the use of oxygen-containing gases in the material gas mixture (col. 15, line 34).

The method and thin film of US '749 differs from the instant invention because US '749 does not disclose following:

a. The step of adding oxygen to the material gas, as recited in claims 10;

b. The concentration of oxygen contained in the material gas is 0.1 to 0.5 ppm based on a concentration of silicon atoms, as recited in claim 10; and

c. The silicon thin film contains oxygen atoms at a concentration of from $1.5x10^{18}$ atoms/cm^3 to $5.0x10^{19}$ atoms/cm^3 as recited in claim 11.

Regarding claim 10, US '794 and US '264 teach methods for reducing the oxygen concentration in the layers of silicon thin films using molecular sieves or zeolites to adsorb oxygen when forming i-type layers for solar cell having pin junctions (US '264 col. 6, line 20). US '264 teaches the formation of an i-type silicon thin film layer having an oxygen concentration less than $5.0x10^{19}$ atoms/cm^3 and as low as $5.0x10^{18}$ atoms/cm^3 (col. 6, line 26). US '794 teaches the formation of an i-type silicon thin film less than $5.0x10^{18}$ atoms/cm^3 or as low as $5.0 x10^{15}$ atoms/cm (col. 8, line 62, col. 9, line 44).

Regarding claim 11, it would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the silicon thin film of US '749 to use a thin film having an oxygen concentration of $1.5x10^{18}$ atoms/cm^3 to $5.0x10^{19}$ atoms/cm^3 as taught by US '264 and US '794 because oxygen in the intrinsic layer of solar cells acts as donor centers and decreases the photo-sensitivity of solar cells (US '794 col. 3, lines 19-42).

Claim 11 is a product-by-process claim, and as such, if the product is the same as or obvious from a product of the prior art, the claim is unpatentable (see MPEP 2113). Since all of the references teach the use of a CVD method and US '794 and US '264 disclose the oxygen concentration in the final product, the instant claims would

have been obvious over the prior art.

Furthermore, in light of the fact that US '794 and US '264 teach the formation of silicon layers having the specified oxygen concentration, and because the oxygen concentration that is deposited is dependent on the concentration contained within the material gas, it would have been inherent in the fabrication process of US '794 and US '264 to have used a material gas with an oxygen concentration of 0.1 to 0.5 ppm based on the concentration of silicon atoms. Using the specified process, a different oxygen concentration would have yielded a different concentration of oxygen in the deposited layer.

Regarding the step of adding oxygen to the material gas as recited in claim 10, the separation of the steps amounts to a rearrangement of the process steps. Instead of providing a gas containing silicon fluoride and hydrogen and then adding oxygen, the prior art teaches that the oxygen is already present in the gas containing silicon fluoride and hydrogen. The selection of any order of performing process steps is prima facie obvious in the absence of new or unexpected results. See In re Burhans, 154 F.2d 690, 69 USPQ 330 (CCPA 1946). As indicated in the instant disclosure, "the oxygen may be added by separately introducing oxygen from an oxygen cylinder," or alternatively, a high amount of oxygen is previously contained in a material gas cylinder and/or a dilute gas cylinder" (see page 25 at lines 1-5).

3. Claim 1, 3-8, and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Matsuda et al. (U.S. Pat. No. 5,571,749) in view of Yamazaki (U.S. Pat. No. 6,028,264) and in view of Yamazaki (U.S. Pat. No. 5,556794), as applied to claims 10-

13 above, and further in view of JP 2000-77694. References to JP 2000-77694 are made using the column and line number references of Higashikawa (U.S. Pat. No. 6,252,158) herein referred to as US '158, which is the U.S. patent in the JP 2000-77694 patent family.

US '749, US '264 and US '794 disclose a method and silicon thin film having the limitations recited in claims 10-13 of the instant invention, as explained above. The method and device described by US '749, US '264 and US '794 further differs from the instant invention because they do not disclose a crystalline phase for the i-type silicon film. For example, US '749, US '264 and US '794 do not teach that said i-type silicon film has a crystalline Raman scattering at least three times greater than the Raman scattering due to amorphous components.

Raman scattering shows the level of crystallization within silicon layers. The ratio of crystalline component to amorphous component gives a measurement for the crystal volume within the layer, i.e., a film having a crystalline component with a Raman scattering three times greater than the Raman scattering of the amorphous component has a crystal volume of 75%.

US '158 teaches a solar cell structure having several microcrystalline intrinsic (i-type) layers with crystal volumes ranging from 30% to 99% (col. 11 , line 66 to col. 12, line 3). Microcrystalline silicon solar cells avoid "the optical degradation phenomenon (Staebler-Wronski effect) specific to the amorphous semiconductors" (col. 2, lines 47-52).

It would have been obvious to one having ordinary skill in the art at the time the

invention was made to have modified the silicon thin film described by US '749, US '264 and US '794 to use a thin film having a crystalline Raman scattering three times greater than the amorphous Raman scattering, as taught by US '158, because a higher crystalline Raman scattering helps avoid the deleterious effects of optical degradation associated with amorphous semiconductors (US '158 col. 2, lines 47-52).

4. Claims 9 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Matsuda et al. (U.S. Pat. No. 5,571,749) in view of Yamazaki (U.S. Pat. No. 6,028,264) and in view of Yamazaki (U.S. Pat. No. 5,556794) and further in view of JP 2000-77694 (US '158), as applied to claims 1, 3-8, and 10-14 above, and further in view of JP 11-310495. References to JP 11-310495 are made using the column and line number references of Kondo (U.S. Pat. No. 6,103,138), herein referred to as US '138, which is the U.S. patent in the JP 11-310495 patent family.

US '749, US '264, US '794, and US '158 describe a method and silicon thin film having the limitations recited in claims 1, 3-8, and 10-14 of the instant invention, as explained above. The silicon film described by US '749, US '264, US '794, and US '158 further differs from the instant invention because they do not disclose having a diffraction intensity of the (220)-plane comprising at least 50% of the total diffraction intensity.

US '138 teaches the use of thin films having diffraction intensities in the (220)-plane at least 30% of the total diffraction intensity because "the thin film will have notable improved carrier mobility" (col. 3, lines 37-40). US '138 further discloses specific examples of thin films having diffraction intensities in the (220)-plane from 50%

to 60% relative to the total diffraction intensity (table 2).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the thin film of US '749, US '264, US '794, and US '158 to use a thin film having a diffraction intensity in the (220)-plane at least 50% of the total diffraction intensity, as taught by US '138, because using such a thin film will have a notably improved carrier mobility (US '138 col. 3, lines 37-40).

Double Patenting

5. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. See *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970);and, *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent is shown to be commonly owned with this application. See 37 CFR 1.130(b).

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

6. Claims 1 and 3-7 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-4 of U.S. Patent No. 6,706,335 in view of Yamazaki (U.S. Pat. No. 6,028,264) and in view of Yamazaki (U.S. Pat. No. 5,556,794), and in view of JP 2000-77694. References to JP 2000-77694 are made using the column and line number references of Higashikawa (U.S. Pat. No. 6,252,158) herein referred to as US '158, which is the U.S. patent in the JP 2000-77694 patent family. Additional evidence regarding silicon fluoride gases is

provided by "Silicon Tetrafluoride" found at

http://www.scottsemicon.com/pures/sif4.html.

Claims 1-4 of US '335 claim a method of forming a silicon thin film formed using a silicon halide and hydrogen, wherein the silicon halide is a silicon fluoride. Claim 3 recites the limitation that the flow rate of hydrogen is not less than the flow rate of the silicon halide. Claim 4 recites the limitation that the pressure is 50 mTorr or more.

US '335 differs from the instant invention because US '335 does not disclose having oxygen present in the material gas at a concentration of from 0.1 ppm to 0.5 ppm, as recited in claims 1 and 4; and an oxygen concentration in the formed silicon film having a concentration of $1.5x10^{18}$ atoms/cm^3 to $5.0x10^{19}$ atoms/cm^3, as recited in claim 5.

US '794 and US '264 teach methods for reducing the oxygen concentration in the layers of silicon thin films using molecular sieves or zeolites to adsorb oxygen when forming i-type layers for solar cells having pin junctions (US '264 col. 6, line 20). US '264 teaches the formation of an i-type silicon thin film layer having an oxygen concentration less than $5.0x10^{19}$ atoms/cm^3 and as low as $5.0x10^{18}$ atoms/cm^3 (col. 6, line 26). US '794 teaches the formation of an i-type silicon thin film less than $5.0x10^{18}$ atoms/cm^3 or as low as $5.0\ x10^{15}$ atoms/cm (col. 8, line 62, col. 9, line 44).

Claim 5 is a product-by-process claim, and as such, if the product is the same as or obvious from a product of the prior art, the claim is unpatentable (see MPEP 2113). Since all of the references teach the use of a CVD method and US '794 and US '264 disclose the oxygen concentration in the final product, the instant claims would

have been obvious over the prior art.

Furthermore, in light of the fact that US '794 and US '264 teach the formation of silicon layers having the specified oxygen concentration, and because the oxygen concentration that is deposited is dependent on the concentration contained within the material gas, it would have been inherent in the fabrication process of US '794 and US '264 to have used a material gas with an oxygen concentration of 0.1 to 0.5 ppm based on the concentration of silicon atoms. Using the specified process, a different oxygen concentration would have yielded a different concentration of oxygen in the deposited layer.

Regarding the step of adding oxygen to the material gas as recited in claim 4, the separation of the steps amounts to a rearrangement of the process steps. Instead of providing a gas containing silicon fluoride and hydrogen and then adding oxygen, the prior art teaches that the oxygen is already present in the gas containing silicon fluoride and hydrogen. The selection of any order of performing process steps is prima facie obvious in the absence of new or unexpected results. See In re Burhans, 154 F.2d 690, 69 USPQ 330 (CCPA 1946). As indicated in the instant disclosure, "the oxygen may be added by separately introducing oxygen from an oxygen cylinder," or alternatively, a high amount of oxygen is previously contained in a material gas cylinder and/or a dilute gas cylinder" (see page 25 at lines 1-5).

The claims of US '335 do not disclose a crystalline phase for its silicon film. US '158 teaches a solar cell structure having several microcrystalline intrinsic (i-type) layers with crystal volumes ranging from 30% to 99% (col. 11 , line 66 to col. 12, line 3).

Microcrystalline silicon solar cells avoid "the optical degradation phenomenon (Staebler-Wronski effect) specific to the amorphous semiconductors" (col. 2, lines 47-52).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the silicon thin film described by the claims of US '335 to use a thin film having a crystalline Raman scattering three times greater than the amorphous Raman scattering, as taught by US '158, because a higher crystalline Raman scattering helps avoid the deleterious effects of optical degradation associated with amorphous semiconductors (US '158 col. 2, lines 47-52).

As a source gas, US '335 defines silicon tetrafluoride as one of the gases that may be used (col. 8, lines 4-17). Silicon tetrafluoride gas typically contains some oxygen gas. For example, Scott Semiconductor Gases provides semiconductor grade silicon tetrafluoride that contains less than 20 ppm of argon + oxygen (see "Silicon Tetrafluoride" found at http://www.scottsemicon.com/pures/sif4.html). Therefore, it appears that the material gas of US '335 would more than likely contain at least some oxygen.

Response to Arguments

7. Applicant's arguments filed October 12, 2004 have been fully considered but they are not persuasive.

Applicant argues that nothing has been found in the cited prior art, when taken separately or in any proper combination, that would teach or suggest that a silicon-based thin film containing crystalline phase is produced using a material gas containing a predetermined concentration of oxygen, as recited in claim 1. However, this argument

is not deemed to be persuasive because the Examiner maintains that the cited prior art does render obvious instant claim 1 and its dependent claims. As noted above, US '264 teaches the formation of an i-type silicon thin film layer having an oxygen concentration less than $5.0x10^{19}$ atoms/cm^3 and as low as $5.0x10^{18}$ atoms/cm^3 (col. 6, line 26). US '794 teaches the formation of an i-type silicon thin film less than $5.0x10^{18}$ atoms/cm^3 or as low as $5.0\ x10^{15}$ atoms/cm (col. 8, line 62; and col. 9, line 44). As also noted above, with respect to crystalline silicon, US '158 teaches a solar cell structure having several microcrystalline intrinsic (i-type) layers with crystal volumes ranging from 30% to 99% (col. 11 , line 66 to col. 12, line 3). Microcrystalline silicon solar cells avoid "the optical degradation phenomenon (Staebler-Wronski effect) specific to the amorphous semiconductors" (col. 2, Lines 47-52).

With respect to the double patenting rejection, Applicant argues that the relied upon references do not recite the features of amended claims 1 and 4. However, this argument is not deemed to be persuasive because claims 1-4 of U.S. Patent No. 6,706,335 in view of Yamazaki (U.S. Pat. No. 6,028,264) and in view of Yamazaki (U.S. Pat. No. 5,556,794), and in view of JP 2000-77694 render obvious instant claims 1-4.

8. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within

TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Alan Diamond whose telephone number is 571-272-1338. The examiner can normally be reached on Monday through Friday, 5:30 a.m. to 2:00 p.m. ET.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam Nguyen can be reached on 571-272-1342. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Alan Diamond
Primary Examiner
Art Unit 1753

Alan Diamond
January 5, 2005